TEST - 12 (Paper - I)

ANSWERS

CHEMISTRY

1. (D)
2. (B)
3. (C)
4. (D)
5. (C)
6. (B)
7. (C)
8. (D)
9. (A, C, D)
10. (A, B, C, D)
11. (A, B, C)
12. (A, D)
13. (C)
14. (A)
15. (C)
16. (C)
17. (B)
18. (C)
19. A $\rightarrow$ (s)
    B $\rightarrow$ (q, r)
    C $\rightarrow$ (p, t)
    D $\rightarrow$ (p, t)
20. A $\rightarrow$ (q)
    B $\rightarrow$ (r)
    C $\rightarrow$ (s, t)
    D $\rightarrow$ (r)

MATHEMATICS

21. (D)
22. (B)
23. (D)
24. (B)
25. (B)
26. (D)
27. (A)
28. (D)
29. (A, B, C)
30. (C, D)
31. (A, C, D)
32. (A, B)
33. (D)
34. (B)
35. (A)
36. (C)
37. (D)
38. (D)
39. A $\rightarrow$ (q)
    B $\rightarrow$ (r)
    C $\rightarrow$ (p, q, r, s, t)
    D $\rightarrow$ (t)
40. A $\rightarrow$ (r)
    B $\rightarrow$ (q)
    C $\rightarrow$ (s, t)
    D $\rightarrow$ (p)

PHYSICS

41. (D)
42. (A)
43. (C)
44. (B)
45. (B)
46. (A)
47. (C)
48. (C)
49. (A, B, C)
50. (A, B, C)
51. (A, C)
52. (A, C, D)
53. (B)
54. (C)
55. (C)
56. (B)
57. (A)
58. (A)
59. A $\rightarrow$ (p, s, t)
    B $\rightarrow$ (q, r)
    C $\rightarrow$ (q, r, s, t)
    D $\rightarrow$ (s, t)
60. A $\rightarrow$ (p, s)
    B $\rightarrow$ (p, s, t)
    C $\rightarrow$ (s, t)
    D $\rightarrow$ (q, s)

ANSWERS & HINTS

PART - I (CHEMISTRY)

1. Answer (D)

Molar conductivity of H^+ and OH^- are very high as compare to other ions.

Initially conductance of solution sharply decreases due to consumption of free H^+ ions, then increases due to formation of salt (NaCN) & after complete neutralization further sharply increases due to presence of OH^-.

2. Answer (B)

Emission of photon of 12.1 eV corresponds to the transition from n = 3 to n = 1.

$$\therefore \text{ change in angular momentum } = (n_2 - n_1)\frac{h}{2\pi}$$

$$= (3-1)\frac{h}{2\pi} = \frac{h}{\pi}$$

$$= \frac{6.6 \times 10^{-34}}{3.14}$$

$$= 2.11 \times 10^{-34} \text{ J s}$$

3. Answer (C)

Activity is same so

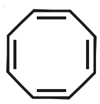
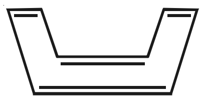
$$\lambda_1 N_1 = \lambda_2 N_2$$

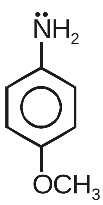
$$\frac{N_1}{N_2} = \frac{.693 \times 20}{8 \times .693} = \frac{20}{8}$$

$$\frac{N_1'}{N_2'} = \frac{20 \times 2^5}{2^2 \,.\, 8} = \frac{20 \times 32}{4 \times 8} = \frac{20}{1}$$

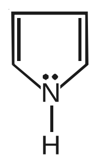
4. Answer (D)

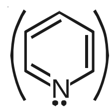
The lone pair of electrons on N atom in N_3^- is in a *sp*^{2} orbital while in NH_2^- it is in *sp*^{3} orbital.

→  is non-planar  (Tub like) so it is not anti aromatic.

→ P-anisidine 

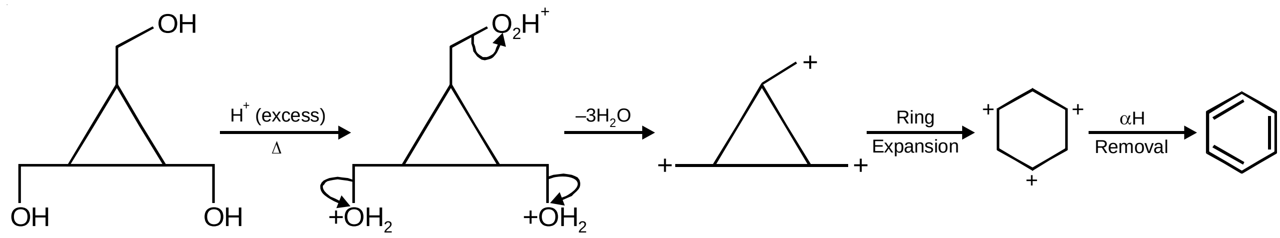
is stronger base than aniline because —OCH_3 shows +R effect.

→ In pyrrole 

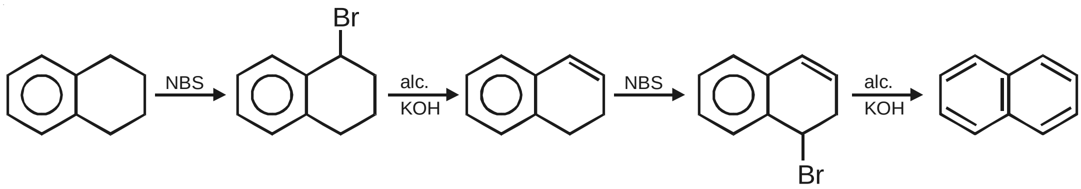
lone pair of electron is involved in resonance but in pyridine 

lone pair of N atom is not involved in resonance.

5. Answer (C)



6. Answer (B)



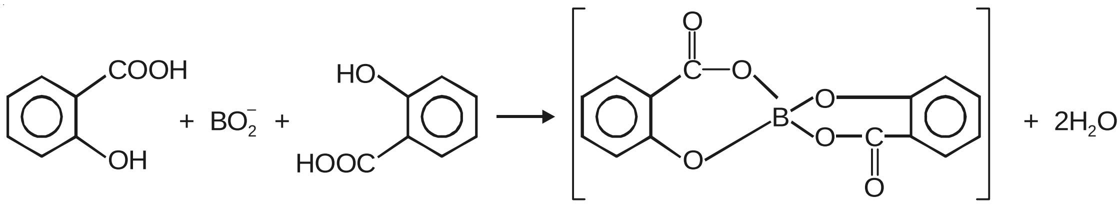
7. Answer (C)

$NH_4NO_3 \xrightarrow{NaOH} NaOH.$

8. Answer (D)

Lone pair on P resides in almost pure *s*-orbital, hence due to non-directional nature. Its overlapping tendency is greatly reduced in comparison to a lone pair present in hybrid orbital, which is directional as present in $\ddot{N}H_3$.

9. Answer (A, C, D)



$B(OH)_3 + H_2O \rightleftharpoons [B(OH)_4]^- + H^+$

$\updownarrow$

$BO_2^- + 2H_2O$

* Optically resolvable due to Asymmetric structure.

* Four six memb. rings.

10. Answer (A, B, C, D)

At the point of maximum value of RDF(Radial Distribution Function)

$$\frac{dP}{dr} = 0$$

$$\left(2r - \frac{2zr^2}{a_0}\right) = 0,\ r = \frac{a_0}{z}$$

where, z = 3 for Li^{+2} & z = 2 for He^{+1} and z = 1 for H

11. Answer (A, B, C)

Fact.

12. Answer (A, D)

$[ZnCl_2Br_2]^{-2}$ and $[Ni(PPH_3)_2Cl_2]$ are tetrahedral complexes.

13. Answer (C)

14. Answer (A)

15. Answer (C)

Solution for Q. 13 to 15

$$Mg \xrightarrow{\text{Dil HCl}} MgCl_2.6H_2O \xrightarrow{Na_2HPO_4} \underset{\text{(white ppt)}}{Mg(NH_4)PO_4} \xrightarrow[\text{HCl gas}]{\Delta} MgCl_2 \xrightarrow[\text{NaCl}]{\text{Electrolysis}} Mg$$

16. Answer (C)
17. Answer (B)
18. Answer (C)

Solution for Q. 16 to 18

For max. conc. of B

$$\frac{d[B]}{dt} = 0, \quad \text{so} \quad t_{max} = \frac{1}{K_2 - K_1} \ln \frac{K_1}{K_2}$$

If $K_2 >> K_1$

Then major portion of B formed will dissociate & if K_1 ⊔ K_2 then relatively larger accumulation of B at the max. conc.

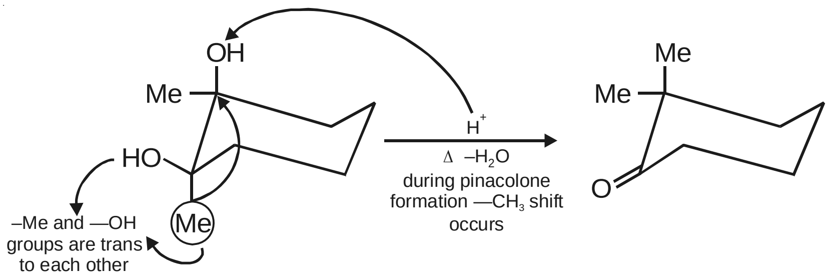
19. Answer A(s), B(q, r), C(p, t), D(p, t)

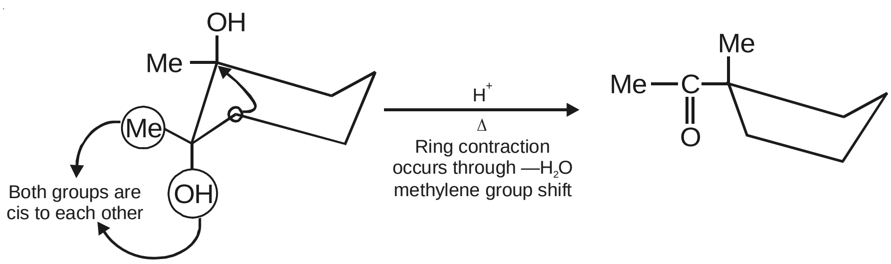
$$* \boxed{\sigma = \pi d^2}, \quad \boxed{z \propto \rho \propto \frac{1}{T}}, \quad \boxed{t \propto \frac{1}{\rho} \propto T}, \quad \boxed{\lambda \propto \frac{1}{\rho} \propto T}$$

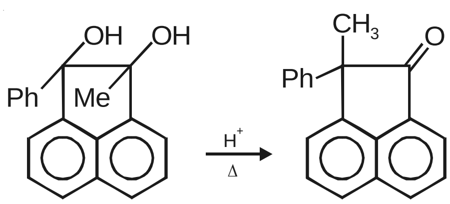
20. Answer A(q), B(r), C(s, t), D(r)

Migration order

H > Aryl > Methyl







PART - II (MATHEMATICS)

21. Answer (D)

$\alpha + \beta = -b/a,\ \alpha\beta = c/a$

$(\alpha + \beta)^2 + (\alpha^2 + \beta^2) + (\alpha - \beta)^2 + \text{..........}$ upto n terms

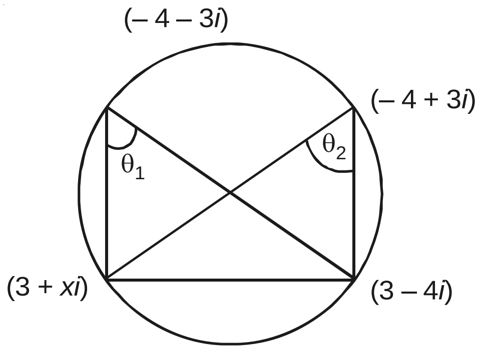
$= \dfrac{n}{2}[2(\alpha+\beta)^2 + (n-1)(-2\alpha\beta)]$

$= \dfrac{n}{2}[2(-b/a)^2 + (n-1)(-2c/a)]$

$= \dfrac{n}{2}\left[\dfrac{2b^2}{a^2} - 2(n-1)\dfrac{c}{a}\right]$

$= \dfrac{n[b^2 - (n-1)ac]}{a^2}$

22. Answer (B)



$\theta_1 = \theta_2$

$\arg\left(\dfrac{7-i}{7+(x+3)i}\right) = \arg\left(\dfrac{7-7i}{7+(x-3)i}\right)$

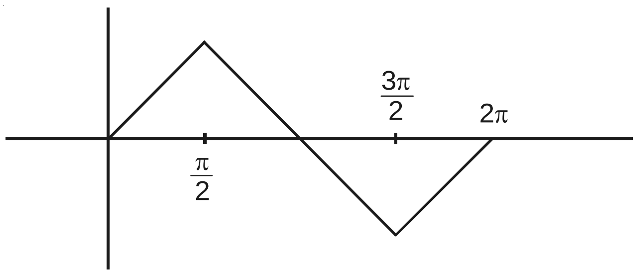
$\Rightarrow \quad x = 4$

23. Answer (D)

To meet at a single line given system of equation has infinite solution

$\therefore \quad \begin{vmatrix} 1 & 1 & -k \\ 3 & -1 & -2 \\ 1 & -1 & 2 \end{vmatrix} = 0 \Rightarrow k = 6$

24. Answer (B)



$y = \sin^{-1}\sin x$ is periodic with fundamental period 2π

and $\displaystyle\int_0^{2\pi} \sin^{-1}\sin x\,dx = 0$ [from the graph]

25. Answer (B)

$y = 3[x] + 4$

$y = 4[x] - 12$

$3[x] + 4 = 4[x] - 12$

$16 = [x]$

$y = 52$

Now $[x - y] = -36$

26. Answer (D)

INCURSION

$N - 2$

$I - 2,\ C - 1,\ 0 - 1,\ S - 1$

Required no. of ways = $\dfrac{9!}{\dfrac{4! \times 2!}{2!}} = \dfrac{9!}{4!}$

27. Answer (A)

Let us put $\sqrt{x} = \tan^2\theta$

$$\frac{1}{2\sqrt{x}}dx = 2\tan\theta.\sec^2\theta d\theta$$

$dx = 4\tan^3\theta.\ \sec^2\theta\ d\theta$

Thus $I = \int \dfrac{4\tan^3\theta.\sec^2\theta d\theta}{\sec\theta}$

$I = \int 4\tan^3\theta \sec\theta d\theta$

Let $\sec\theta = z$

$\Rightarrow$ $\sec\theta.\ \tan\theta\ d\theta = dz$

$I = \int 4(z^2 - 1)\,dz$

$= 4\dfrac{z^3}{3} - 4z + c$

$= \dfrac{4}{3}(\sec^3\theta) - 4\sec\theta + c$

$= \dfrac{4}{3}(1 + \sqrt{x})^{3/2} - 4(\sqrt{1 + \sqrt{x}}) + c$

28. Answer (D)

Required area $= 2\int_0^1 \dfrac{x}{\sqrt{1 - x^2}}\,dx$

= put $1 - x^2 = z$

$- 2x dx = dz$

$$\int_1^0 \frac{-dz}{\sqrt{z}}$$

$$= \int_0^1 \frac{1}{\sqrt{z}}dz = 2$$

29. Answer (A, B, C)

$(1 + x)^n (1 + y)^n (x + y)^n$

$= ({}^nC_0 + {}^nC_1x + {}^nC_2x^2 + ... + {}^nC_nx^n)$

$({}^nC_0y^n + {}^nC_1y^{n-1} + {}^nC_2y^{n-2} + ... + {}^nC_ny^0)$

$= ({}^nC_0)^3 + ({}^nC_1)^3 + ({}^nC_2]^3 + ... + ({}^nC_n)^3$

$$= \sum_{r=0}^{x} C_r^3$$

30. Answer (C, D)

$$\int_1^\infty \left(\frac{1}{\sqrt{x}} - \frac{1}{\sqrt{x+3}}\right) dx$$

$$I = \lim_{x \to \infty} \int_1^x \left(\frac{1}{\sqrt{x}} - \frac{1}{\sqrt{x+3}}\right) dx$$

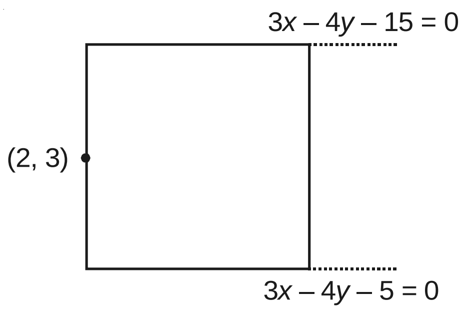
$$I = \lim_{x \to \infty} \int_1^x \left(\frac{1}{\sqrt{x}} - \frac{1}{\sqrt{x+3}}\right) dx$$

$$= \lim_{x \to \infty} [2\sqrt{x} - 2\sqrt{x+3}] - [2 - 2\sqrt{4}]$$

$$= \lim_{x \to \infty} 2\left[\frac{-3}{\sqrt{x} + \sqrt{x+3}}\right] - [-2]$$

$= 2$

31. Answer (A, C, D)



Equation of side passing through (2, 3) is

$4x + 3y - (4 \times 2 + 3 \times 3) = 0$

$4x + 3y - 17 = 0$

Also distance between $3x - 4y - 15 = 0$ and $3x - 4y - 5 = 0$ is $\left|\frac{10}{5}\right| = 2$

other equation is $4x + 3y + k = 0$

Now $\left|\frac{k+17}{5}\right| = 2$

$k + 17 = \pm 10$

$k = -7, -27$

32. Answer (A, B)

Equation of circle passing through given circles is $x^2 + y^2 - 4x - 5 + \lambda(x^2 + y^2 + 8y + 7) = 0$

Centre $\equiv \left(\frac{2}{1+\lambda}, \frac{-4\lambda}{1+\lambda}\right)$

Equation of common chord is $S_1 - S_2 = 0$

$$4x + 8y + 12 = 0$$

Centre lies on $4x + 8y + 12 = 0$

$\therefore \quad \lambda = 1$

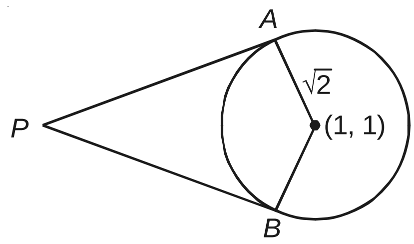
Now, equation of circle is

$x^2 + y^2 - 2x + 4y + 1 = 0$

Centre $\equiv (1, -2)$

radius $= \sqrt{1+4-1} = 2$

33. Answer (D)



$r = \sqrt{2}$

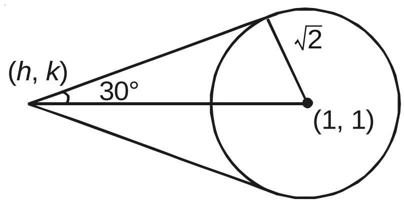
$PA = \sqrt{4^2 + 4^2 - 2.4 - 2.4}$

$= 4$

Required area $= \left(\frac{1}{2} \times 4 \times \sqrt{2}\right) \times 2$

$$= 4\sqrt{2}$$

34. Answer (B)



$\tan 30° = \frac{\sqrt{2}}{\sqrt{h^2 + k^2 - 2h - 2k}}$

$\frac{1}{\sqrt{3}} = \frac{\sqrt{2}}{\sqrt{h^2 + k^2 - 2h - 2k}}$

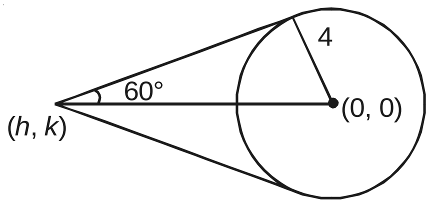
$\Rightarrow \quad \frac{1}{3} = \frac{2}{h^2 + k^2 - 2h - 2k}$

$\Rightarrow \quad h^2 + k^2 - 2h - 2k = 6$

$\Rightarrow \quad h^2 + k^2 - 2h - 2k - 6 = 0$

$\therefore \quad$ Locus of (h, k) is $x^2 + y^2 - 2x - 2y - 6 = 0$

35. Answer (A)



$\tan 60° = \frac{4}{\sqrt{h^2 + k^2 - 16}}$

$\Rightarrow \quad \sqrt{3} = \dfrac{4}{\sqrt{h^2 + k^2 - 6}}$

$\Rightarrow \quad 3 = \dfrac{16}{h^2 + k^2 - 16}$

$\Rightarrow \quad 3h^2 + 3k^2 - 48 = 16 \Rightarrow h^2 + k^2 - \dfrac{64}{3} = 0$

36. Answer (C)

$n(S) = {}^{30}P_9 = \dfrac{30!}{21!}$

For trace to be maximum elements along principal diagonal should be 30, 29, 28

$n(E) = {}^{27}E_6 \times 3! = \dfrac{3! \times 27!}{21!}$

$P(E) = \dfrac{3! \times 27!}{30!} = \dfrac{1}{4060}$

37. Answer (D)

Let element along principal diagonal *bc*, *a*, *b*, *c*

$2b = a + b$

$\Rightarrow \quad a + c = \text{even}$

$n(E) = 2 \times {}^{15}C_2 \times {}^{27}P_6 \times 2$

$P(E) = \dfrac{4 \times {}^{15}C_2 \times {}^{27}P_6}{{}^{30}P_9}$

$= \dfrac{4 \times 105 \times \dfrac{27!}{21!}}{\dfrac{30!}{21!}} = 420 \times \dfrac{27!}{30!} = \dfrac{1}{58}$

38. Answer (D)

$$\begin{bmatrix} a_1 & & \\ & a_2 & \\ & & a_3 \end{bmatrix}$$

$A_1 = \{1, 4, 7, ..., 28\}$

$A_2 = \{2, 5, 8, ..., 29\}$

$A_3 = \{3, 6, 9, ..., 30\}$

Number of triplets whose sum is divisible by 3

$= {}^{10}C_3 + {}^{10}C_3 + {}^{10}C_3 + {}^{10}C_1 \times {}^{10}C_1 + {}^{10}C_1$

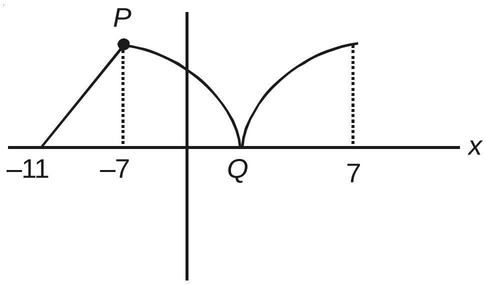
$= 1360$

Total number of such matrix

$= 1360.3! \times {}^{27}P_6$

$68.5! \times {}^{27}P_6$

39. Answer A(q), B(r), C(p, q, r, s, t), D(t)



P,Q are critical point

(B) y will be maximum when

$$x = \frac{4}{100} \times 25 = 1$$

(C) $f'(x) = -6x^2 + 42x - 60$

$= -6(x^2 - 7x + 10)$

$-6(x-5)(x-2)$

$f(x)$ decreases in $(-\infty, 2)$

$f(2) = -16 + 84 - 120 + 41$

$= 125 - 136$

$= -11$

(D) $y = \frac{1}{2}(|x+2| - |x-2| + 2)$

when $x < -2$

$$y = \frac{1}{2}(-x - 2 + x - 2 + 2)$$

$= -1$

When $-2 \le x \le 2$

$$\frac{1}{2}(x + 2 + x - 2) + 2$$

$$\frac{1}{2}(2x + 2)$$

$x + 1$

$x > 2$

$$y = \frac{1}{2}(x + 2 - x + 2 + 2)$$

$$\frac{1}{2}(6) = 3$$

Least value of $f(x) = -1$

40. Answer A(r), B(q), C(s, t), D(p)

$$\int_0^1 \sin\frac{\pi}{4}x\,dx$$

$$=\frac{4}{\pi}\left[-\cos\frac{\pi}{4}x\right]_0^1$$

$$\frac{4}{\pi}\left[\frac{-1}{\sqrt{2}}+1\right]$$

$$\frac{4}{\pi}\left[\frac{\sqrt{2}-1}{\sqrt{2}}\right]$$

$$\frac{2\sqrt{2}(\sqrt{2}-1)}{\pi}$$

(B) Any passes through the point of intersection of given planes is $4x + y - 3z - 1 + \lambda(x - 3y + z + 2) = 0$

It passes through (1, – 2, 3)

$\therefore\ \lambda = 2/3$

Required equation is $14x - 3y - 7z + 1 = 0$

$d = 1$

(C) $A = (6, 10, 10)$

$B = (1, 0, -5)$

$C = (6, -10, \lambda)$

$AB^2 = 350$

$AC^2 = 500 - 20\lambda + \lambda^2$

$BC^2 = 150 + 10\lambda + x^2$

Case-I, $AB^2 + AC^2 = BC^2$

$\Rightarrow\ \lambda = \dfrac{70}{3}$

Case-II, $AB^2 + BC^2 = AC^2$

$\Rightarrow\ \lambda = 0$

Case-II, $BC^2 + AC^2 = AB^2$

$\Rightarrow\ \lambda^2 - 5\lambda + 150 = 0$ no real λ exists.

(D) $\vec{a}-\vec{d}, \vec{b}-\vec{d}, \vec{c}-\vec{d}$ are coplanar

$$\therefore\ \{\vec{a}-\vec{d}, \vec{b}-\vec{d}, \vec{c}-\vec{d}\} = 0$$

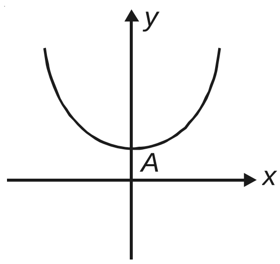
$$\Rightarrow\ [\vec{a}\ \vec{b}\ \vec{c}] = [\vec{b}\ \vec{c}\ \vec{d}] + [\vec{c}\ \vec{a}\ \vec{d}] + [\vec{a}\ \vec{b}\ \vec{d}]$$

$$= -[\vec{b}\ \vec{d}\ \vec{c}] + [\vec{c}\ \vec{d}\ \vec{a}] + [\vec{a}\ \vec{d}\ \vec{b}]$$

$\therefore\quad \lambda = -1$

PART - III (PHYSICS)

41. Answer (D)



$y = x^2 + 2$

$v_y = 2x\, v_x$

$a_y = 2v_x^2 + 2x\, a_x$

At point A, $x = 0$, $v_y = 0$, $v_x = 2$

$a_y = 2(2)^2 = 8$

At point y is minimum so the speed is minimum and $a_x = 0$.

42. Answer (A)

$60 - 10 - 2T = 1.a$ ...(i)

$T - 20 = 2.a'$ $\left(\frac{a'+0}{2} = a\right)$

So $2T - 40 = 8a$ ...(ii)

Adding eq. (i) and (ii)

$10 = 9a$

$\Rightarrow a = \frac{10}{9}$

$\Rightarrow a' = \frac{20}{9}$ m/s^2

43. Answer (C)

For first three seconds,

$a = \frac{40-20}{4} = 5$ m/s^2

$\Rightarrow$ Displacement in 3 s

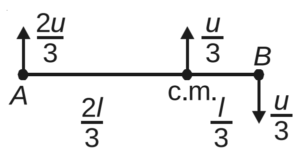
$S = 0 + \frac{1}{2}.5(3)^2 = \frac{45}{2}$m

$\Rightarrow$ Displacement in 6 s = 45 m

$\Rightarrow$ Work done by friction = – 45 · 20 = – 900 J

44. Answer (B)

In c.m. frame initial velocities are as shown



45. Answer (B)

46. Answer (A)

Initial energy = $U = \frac{Q^2}{8\pi\varepsilon_0 R}$

Final energy = $U' = \frac{Q^2}{2\left(\frac{4\pi\,\varepsilon_0\, R\,.\,2R}{2R-R}\right)} = \frac{Q^2}{16\,\pi\,\varepsilon_0 R} = \frac{U}{2}$

47. Answer (C)

$D_{max} = 180 - 2i_c = 60°$

$$\left(\sin i_c = \frac{\frac{2}{\sqrt{3}}}{\frac{4}{3}} = \frac{\sqrt{3}}{2} \Rightarrow i_c = 60° \right)$$

48. Answer (C)

Power supplied to capacitor will be maximum when

$$i = \frac{E}{2R}(1 - e^{-t/\tau}) = \frac{E}{2R}$$

$\Rightarrow$ $t = (\ln 2)\, \tau = 60 \ln 2$ ms

49. Answer (A, B, C)

Quantities constituting set of fundamental quantities should not be derivable from each other.

50. Answer (A, B, C)

$$T = 2\pi \sqrt{\frac{3}{75}} = \frac{2\pi}{5} \text{s}$$

Acceleration = $A\omega^2$

$$\Rightarrow \quad \frac{50 \times 0.2}{3} = A\,\frac{75}{3} \quad \Rightarrow \quad A = \frac{2}{15}\text{ m} = \frac{40}{3}\text{ cm}$$

51. Answer (A, C)

$W_{AB} = 2\,RT_0 \ln 2,$ $\quad W_{BC} = W_{DA} = 0$

$W_{CD} = -\,6\,RT_0 \ln 2,$ $\quad W_{cycle} = -\,4\,RT_0 \ln 2$

52. Answer (A, C, D)

53. Answer (B)

$$-\frac{dN_A}{dt} = \lambda N_A - \alpha$$

$$N_A = \frac{\alpha}{\lambda}\left(1 - e^{-\lambda t}\right) \qquad t \le \frac{\ln 2}{\lambda}$$

At $t = t \le \dfrac{\ln 2}{\lambda}$ $\qquad \Rightarrow \quad e^{\lambda t} = 2$

$$N_A = \frac{\alpha}{2\lambda}$$

54. Answer (C)

$\dfrac{dN_B}{dt}$ is maximum, when N_A is maximum

$$\Rightarrow \quad \alpha \,.\, \frac{\ln 2}{\lambda} = \frac{\alpha}{2\lambda} + N_B$$

$$\Rightarrow \quad N_B = \frac{\alpha}{\lambda}\left(\ln 2 - \frac{1}{2}\right)$$

55. Answer (C)

56. Answer (B)

By $F = ma$,

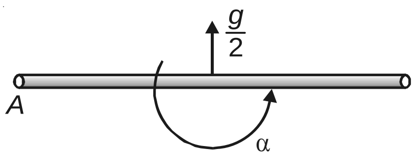
$$\frac{3mg}{2} - mg = ma \quad \Rightarrow \quad a = \frac{g}{2}$$

57. Answer (A)

$$\left(mg.\frac{l}{2} - \frac{mg}{2}.\frac{l}{2}\right) = \frac{ml^2}{12}.\alpha \quad \Rightarrow \quad \frac{mgl}{4} = \frac{ml^2}{12}.\alpha$$

$$\Rightarrow \quad \alpha = \frac{3g}{l}$$

58. Answer (A)



$$G_A = \alpha.\frac{l}{2} - \frac{g}{2}$$

$$= \frac{3g}{l}.\frac{l}{2} - \frac{g}{2} = g$$

59. Answer A(p, s, t), B(q, r), C(q, r, s, t), D(s, t)

60. Answer A(p, s), B(p, s, t), C(s, t), D(q, s)

q q q

TEST - 12 (Paper - II)

ANSWERS

CHEMISTRY

1. (C)
2. (D)
3. (B)
4. (A)
5. (A, C, D)
6. (A, C)
7. (A, D)
8. (B, C)
9. (A, B, C, D)
10. A $\rightarrow$ (p, r)
    B $\rightarrow$ (p, q, r, s, t)
    C $\rightarrow$ (q)
    D $\rightarrow$ (p, q, t)
11. A $\rightarrow$ (q, r, s)
    B $\rightarrow$ (q, r, s)
    C $\rightarrow$ (p, q, s, t)
    D $\rightarrow$ (q, s, t)
12. (8)
13. (9)
14. (5)
15. (3)
16. (6)
17. (3)
18. (1)
19. (6)

MATHEMATICS

20. (A)
21. (C)
22. (B)
23. (D)
24. (A, B)
25. (C, D)
26. (B, C)
27. (A, D)
28. (A, B, C, D)
29. A $\rightarrow$ (p)
    B $\rightarrow$ (q, t)
    C $\rightarrow$ (r)
    D $\rightarrow$ (s)
30. A $\rightarrow$ (p, q)
    B $\rightarrow$ (p, r, s, t)
    C $\rightarrow$ (p, q, r)
    D $\rightarrow$ (r)
31. (9)
32. (5)
33. (8)
34. (0)
35. (4)
36. (5)
37. (9)
38. (2)

PHYSICS

39. (B)
40. (B)
41. (C)
42. (D)
43. (A, B)
44. (B, D)
45. (A, C)
46. (C, D)
47. (B, C)
48. A $\rightarrow$ (p, q, s, t)
    B $\rightarrow$ (q, r)
    C $\rightarrow$ (p, q, t)
    D $\rightarrow$ (q, r, s, t)
49. A $\rightarrow$ (p)
    B $\rightarrow$ (r, t)
    C $\rightarrow$ (r, s, t)
    D $\rightarrow$ (p, q, s)
50. (8)
51. (4)
52. (4)
53. (4)
54. (2)
55. (4)
56. (5)
57. (8)

ANSWERS & HINTS

PART - I (CHEMISTRY)

1. Answer (C)

(i) $NaNO_3 \xrightarrow{\Delta} NaNO_2 + \frac{1}{2}O_2$

(ii) $Cu(NO_3)_2 \xrightarrow{\Delta} CuO + 2NO_2\uparrow + \frac{1}{2}O_2\uparrow$

(iii) $Hg(NO_3)_2 \xrightarrow{\Delta} Hg\downarrow + 2NO_2\uparrow + O_2\uparrow$

(iv) $AgNO_3 \xrightarrow{\Delta} Ag + NO_2\uparrow + \frac{1}{2}O_2\uparrow$

2. Answer (D)

$$\frac{P^\circ_A - P_A}{P^\circ_A} = x_B$$

$$\frac{w_2}{w_1+w_2} = \frac{wM}{mW}$$

$$\frac{0.04}{2.54} = \frac{5\times 18}{m\times 80}$$

m = 70.3

3. Answer (B)

4. Answer (A)

This is an example of intramolecular electrophilic substitution.

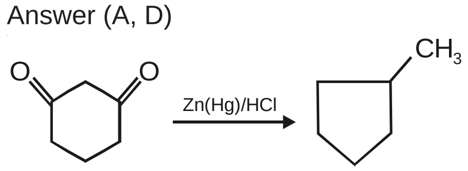
5. Answer (A, C, D)

Fact.

6. Answer (A, C)

Fact.

7. Answer (A, D)



8. Answer (B, C)

Fact.

9. Answer (A, B, C, D)

* $[MnF_6]^{-4}$ t_{2g}: [↑][↑][↑] e_g: [↑][↑]

$CFSE_{(Octahedral)} = -0.4\, n_{(t_{2g})} + 0.6\, n_{(e_g)}$

$= -1.2 + 1.2 = 0$

* CFSE in $[Mn(CN)_6]^{-4}$ t_{2g}: [↑↓][↑↓][↑] e_g: [ ][ ]

$CFSE = -0.4\, n_{(t_{2g})} + 0.6\, n_{(eg)}$

$= -0.4 \times 5 + 0.6 \times 0 = -2.0$

*	'en' is symmetrical bidentate ligand so geometrical isomers are not possible.

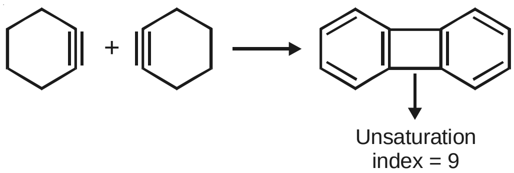
*	'gly' is unsymmetrical bidentate ligand so geometrical isomers are possible.

10. Answer A(p, r), B(p, q, r, s, t), C(q), D(p, q, t)
11. Answer A(q, r, s), B(q, r, s), C(p, q, s, t), D(q, s, t)
12. Answer (8)

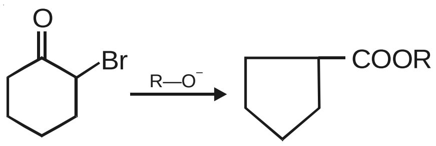
Amphibole silicates are double standard silicates and one tetrahedron shares three corners while other adjacent one shares only two corners hence average shared corners = $\frac{3+2}{2}$ = 2.5.

$\therefore$ 2x = 5

13. Answer (9)



14. Answer (5)



15. Answer (3)

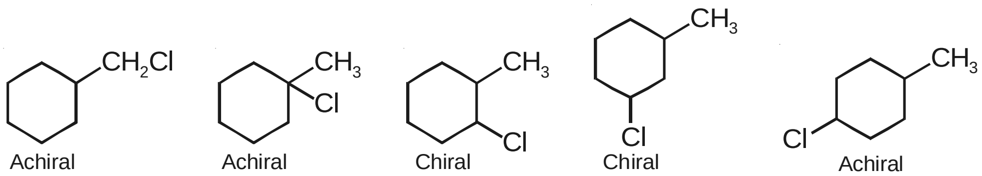
Fact.

16. Answer (6)

For 1 mole Ca deposition 2 faraday charge is requried.

For 3 moles Ca deposition 6 faraday charge is requried.

17. Answer (3)



18. Answer (1)
19. Answer (6)

PART - II (MATHEMATICS)

20. Answer (A)

$$\frac{dy}{dx} + y\, f'(x) = f(x).\, f'(x)$$

$$\frac{dy}{dx} = \{f(x) - y\}.f'(x)$$

Let $f(x) - y = z$

$$\Rightarrow \quad \frac{dy}{dx} = f'(x) - \frac{dx}{dx}$$

$$f'(x) - \frac{dz}{dx} = zf'(x)$$

$\therefore \quad \dfrac{dz}{dx} = (1-z)\,f'(x)$

$f(x) + \log(1-z) = c$

$\therefore \quad f(x) + \log(1+y-f(x)) = c$

21. Answer (C)

For points to be collinear

$x\hat{i} + y\hat{j} + z\hat{k} = \lambda_1(\hat{i} + z\hat{j}) + \lambda_2(-\hat{i} - \hat{j})$

On equality

$z = 0,\ x = 1 + 2y$

22. Answer (B)

For lines to be coplanar

$$\begin{vmatrix} 2-1 & 3-4 & 4-5 \\ 1 & 1 & -k \\ k & 2 & 1 \end{vmatrix} = 0$$

$\Rightarrow \quad k = 0$ or -3

23. Answer (D)

Length of focal chord making angle 'θ' with major axis = $\dfrac{2ab^2}{a^2\sin^2\theta + b^2\cos^2\theta}$

$$= \frac{2\times 3\times 4}{9\times\frac{3}{4} + 4\times\frac{1}{4}} = \frac{24}{\frac{27}{4}+1} = \frac{96}{31}$$

24. Answer (A, B)

$\dfrac{x^2}{18} - \dfrac{y^2}{9} = 1$

Required equations are

$y = -x \pm \sqrt{18-9}$

$y = -x \pm 3$

25. Answer (C, D)

a, b, c are in H.P

$\dfrac{2}{b} = \dfrac{1}{a} + \dfrac{1}{c}$

$$\frac{\frac{1}{b}+\frac{1}{a}}{\frac{2}{b}-\frac{1}{a}} + \frac{\frac{1}{b}+\frac{1}{c}}{\frac{2}{b}-\frac{1}{c}} = \frac{\frac{1}{b}+\frac{1}{a}}{\frac{1}{c}} + \frac{\frac{1}{b}+\frac{1}{c}}{\frac{1}{a}} = \frac{a+c}{b} + \frac{a}{c} + \frac{c}{a}$$

as AM > GM

$\dfrac{a}{c} + \dfrac{c}{a} > 2 \qquad \text{...(i)}$

Also $\dfrac{a+c}{2} > \dfrac{2ac}{a+c} = b$

$\therefore \quad \left(\dfrac{a+c}{b}\right) + \left(\dfrac{a}{c} + \dfrac{c}{a}\right) > 4$

26. Answer (B, C)

$(x + 3)^5 - (x - 1)^5 \geq 244$

Let $y = \dfrac{x+3+x-1}{2} = x+1$

Now $(y + 2)^5 - (y - 2)^5 \geq 244$

$2[{}^5C_1 y^4.2 + {}^5C_3.y^2.z^3 + {}^5C_5 2^5] \geq 244$

$y^4 + 8y^2 - 9 \geq 0$

$(y^2 + 9)(y^2 - 1) \geq 0$

$y \in (-\infty, -1] \cup [1, \infty)$

$\Rightarrow \quad x \in (-\infty, -2] \cup [0, \infty)$

27. Answer (A, D)

We have,

$\cos 2x = 1/3$

$\Rightarrow \quad \dfrac{1-\tan^2 x}{1+\tan^2 x} = \dfrac{1}{3}$

$\Rightarrow \quad \tan^2 x = \dfrac{3-1}{3+1} = \dfrac{1}{2}$

$\Rightarrow \quad 2\cos^2\theta - 3\cos\theta = 2$

$\cos\theta = -1/2$

$\theta = 2n\pi \pm 2\pi/3, n \in Z$

28. Answer (A, B, C, D)

$\lim\limits_{x\to 0} \dfrac{a+bx\sin x+c\cos x}{x^4} = 2$ to exist limiting value ...(i)

$a + c = 0$

From, L'Hospital rule

$$\lim_{x\to 0} \frac{b\sin x+bx\cos x-c\sin x}{4x^3} = 2$$

$$\lim_{x\to 0} \frac{b\cos x+b\cos x-bx\sin x-c\cos x}{12x^2} = 2$$

for the existence of limiting value, we have

$2b - c = 0$ ...(ii)

Again, $\lim\limits_{x\to 0} \dfrac{-2b\sin x+c\sin x-bx\cos x-b\sin x}{24\,x} = 2$

Again, apply L' Hospital rule

$$\lim_{x\to 0} \frac{-2b\cos x+c\cos x-b\cos x+bx\sin x-b\cos x}{24} = 2$$

$\Rightarrow \quad -2b + c - b - b = 48$

$\Rightarrow \quad -4b + c = 48$ ...(iii)

From (i), (ii), (iii)

$a = 48, c = -48, b = -24$

29. Answer A(p), B(q, t), C(r), D(s)

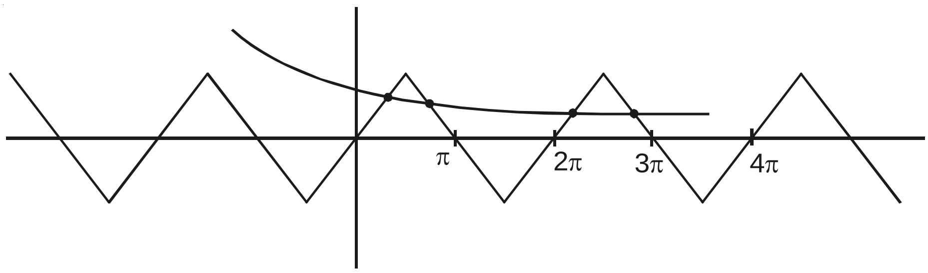
(A) $I_1 + I_2 = \int_{-1}^{1} x^2 dx$

$= 2\int_{0}^{1} x^2 dx = 2.\frac{1}{3} = \frac{2}{3}$

(B) $\int_{-2}^{5} \{x\} dx = \frac{7}{2}$

(C) From graph there is only one solution at $x = \sqrt{2}$

(D)



Number of solution = 4

30. Answer A(p, q), B(p, r, s, t), C(p, q, r), D(r)

(A) To represent ellipse

$\sqrt{3^2 + 4^2} < k$

$k > 5$

(B) To represent hyperbola

$-\sqrt{41} < k < \sqrt{41}$ except '0'

(C) To represent circle

$k > 0$ and $k \neq 2$

(D) To represent line

$k = 1$

31. Answer (9)

$\int_{0}^{9} \frac{dx}{(x-1)^{2/3}}$

$[3(x-1)^{1/3}]_0^9$

3[2 – (–1)] = 9

32. Answer (5)

$5 - 1 + \frac{1}{5} - \frac{1}{25} + ...$

$r = \frac{-1}{5}$

$S_\infty = \frac{5}{1-(-1/5)} = \frac{25}{6} \quad \therefore k = 5$

33. Answer (8)

$$\frac{d^n}{dx^n}(x^{n-1}\log x) = \frac{(n-1)!}{x}$$

$$\frac{d^{10}x^9\log x}{dx^{10}} = \frac{9!}{x}$$

$\therefore \quad k = 8$

34. Answer (0)

$xy = c$

$$x\frac{dy}{dx} + y = 0$$

$$\frac{dy}{dx} = \frac{-y}{x}$$

$\Rightarrow$ For orthogonal trajectory

$$-\frac{dx}{dy} = \frac{-y}{x}$$

$xdx = ydy$

$x^2 - y^2 = c$

$\therefore \quad a = 1, b = -1, h = 0$

$\therefore \quad a + b = 0$

35. Answer (4)

$^{46}C_4 + {}^{49}C_3 + {}^{48}C_3 + {}^{47}C_3 + {}^{46}C_3 + {}^{54}C_{51} + {}^{53}C_{50} + {}^{52}C_{49} + {}^{51}C_{48} + {}^{50}C_{47} = {}^{55}C_4$

$\therefore \quad r = 4$

For no common point means given system of equation has no solution.

36. Answer (5)

$\Delta = \begin{vmatrix} 2 & 3 & 1 \\ 3 & 1 & k \\ 1 & 4 & -2 \end{vmatrix} = 0$, and any one of Δ_1, Δ_2, Δ_3 is nonzero

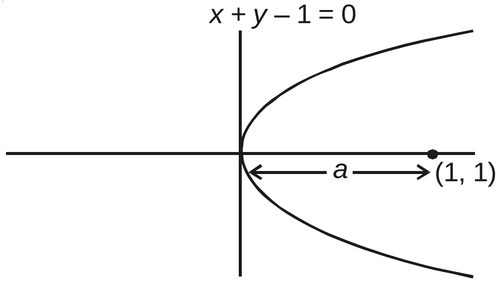
$k = 5$

For $k = 5$ given system has no solution.

37. Answer (9)

The sum of solutions of the given equation is 14 which can be expressed as 2 × 7. The sum of prime factors is 9.

38. Answer (2)



Distance between tangent at vertex and focus

$= a = \dfrac{1}{\sqrt{2}}$

Length of latus rectum $4a = 2\sqrt{2}$

$\therefore \quad k = 2$

PART - III (PHYSICS)

39. Answer (B)

$$E_n = -13.6 \frac{Z^2}{n^2} \text{ eV}$$

For, He^+ ion, $Z = 2$

$$E_n = -\frac{13.6 \times 2^2}{n^2} \text{ eV}$$

Energies of photons

$$E_1 = \frac{12430}{1085} = 11.4 \text{ eV}$$

$$E_2 = \frac{12430}{304} = 40.9 \text{ eV}$$

$E = E_1 + E_2 = 52.3$ eV

From,

$$52.3 = E = -(54.4 \text{ eV})\left(\frac{1}{1^2} - \frac{1}{n^2}\right)$$

$\Rightarrow$ $n^2 = 25$

$\Rightarrow$ $n = 5$

40. Answer (B)

Equivalent emf of 10 V and 4 V cells is 7 V

$\Rightarrow$ Current through 7 V cell is zero

$\Rightarrow$ Terminal potential difference = 7 V

41. Answer (C)

$$\frac{1}{2} mv^2 = 0.0327 \times 1.6 \times 10^{-19} \text{ joule}$$

$v = 2500$ m/s

time in travel of 3500×10^3

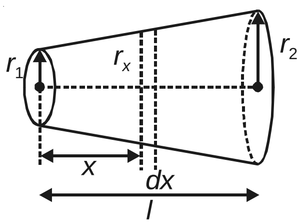
$$t = \frac{3500 \times 10^3}{2500} \text{ s} = 1400\text{s} = 2 \text{ half lives}$$

$\Rightarrow$ Fraction decayed = 0.75

42. Answer (D)

$$r_x = r_1 + \left(\frac{r_2 - r_1}{l}\right) x$$

For element



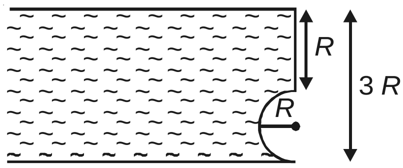
$$dl = \frac{F\,dx}{A_x Y}$$

$$\Rightarrow \quad dl = \frac{F\,dx}{\pi r_x^2 Y}$$

Integrating

$$\Delta l = \int_0^l \frac{F\,dx}{\pi\left[r_1 + \left(\frac{r_2 - r_1}{l}\right)x\right]^2 Y} = \frac{Fl}{\pi r_1 r_2 Y}$$

43. Answer (A, B)



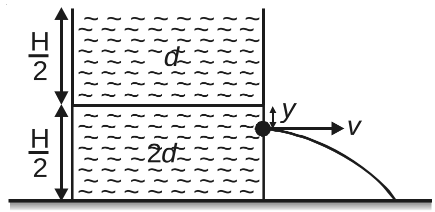
Force on the gate

$F_H = P_{av} \times$ Vertical area of gate

$$= \frac{R\rho g + 3R\rho g}{2} \times 2R \times l$$

$$= 4\,\rho g R^2 l$$

44. Answer (B, D)



For velocity of efflux

$$\frac{H}{2}dg + y.2dg = \frac{1}{2}2d.v^2$$

$$v^2 = \frac{gH}{2} + 2gy$$

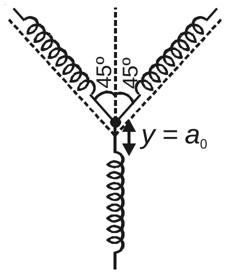
time in falling, $t = \sqrt{\dfrac{2\left(\dfrac{H}{2} - y\right)}{g}}$

Horizontal range, $R^2 = \dfrac{2\left(\dfrac{H}{2} - y\right)}{g}.\left[\dfrac{gH}{2} + 2gy\right]$

For maximum, $\dfrac{dR^2}{dy} = 0 \Rightarrow y = \dfrac{H}{8}$

$\therefore$ depth of hole $= \dfrac{H}{2} + \dfrac{H}{8} = \dfrac{5H}{8}$ and $R_{max} = \dfrac{3H}{4}$

45. Answer (A, C)



$F_{rest} = (2 \times 2k \cos^2 45 + 2k)\,(-y)$

$= -\,4\,ky$

$\Rightarrow \quad \omega = \sqrt{\dfrac{4k}{m}}$

If maximum displacement is a_0, then,

$v_{max} = a\omega = 2a_0\sqrt{\dfrac{k}{m}}$

and $A_{max} = a\omega^2 = 4a_0\left(\dfrac{k}{m}\right)$

46. Answer (C, D)

If TV = Constant

$\Rightarrow \quad PV^2$ = Constant (From $PV = nRT$)

From $PV = nRT$

$\therefore$ Molar specific heat

$$C = \frac{R}{\gamma - 1} + \frac{R}{1 - x}$$

$$C_{mono} = \frac{R}{\frac{5}{3} - 1} + \frac{R}{1 - 2}$$

$$= \frac{3}{2}R - R = \frac{R}{2}$$

$$C_{dia} = \frac{R}{\frac{7}{5}-1} + \frac{R}{1-2}$$

$$= \frac{5}{2}R - R$$

$$= \frac{3R}{2}$$

$$C_{dia} - C_{mono} = \frac{3R}{2} - \frac{R}{2} = R$$

47. Answer (B, C)

$$t_1 = \frac{PL}{2KT}\left(1^2 - 0^2\right) = \frac{PL}{2KT}$$

$$t_2 = \frac{PL}{2KT}(2^2 - 1^2) = \frac{3PL}{2KT}$$

$$t_2 = 3t_1$$

$$\frac{t_1}{t_2} = \frac{1}{3}$$

and $t_1 = \dfrac{\rho L}{2K \times T}$

48. Answer A(p, q, s, t), B(q, r), C(p, q, t), D(q, r, s, t)

49. Answer A(p), B(r, t), C(r, s, t), D(p, q, s)

If the force on the particle is always parallel to the velocity the path of the particle will be straight line or if the force on the particle is zero then also the path of the particle will be straight line.

(A) If $v_0 = \dfrac{E_0}{B_0}$ then the net lorentz force on the partical will be zero.

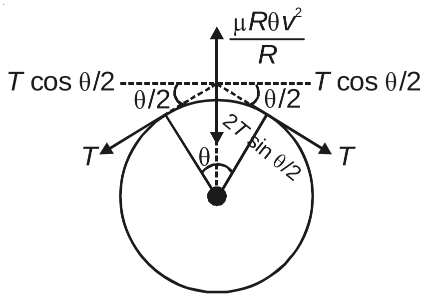
(B) As the velocity is parallel to the magnetic field the force on the particle will be zero.

(C) Again the force due to magnetic field is zero. And velocity is parallel to the electric field.

(D) As $\vec{B} = 0$ and the velocity remains parallel to the magnetic field so the force will be always parallel to the velocity hence the path of the particle will be straight line.

50. Answer (8)

If mass per unit length is ‘μ’ then



$$\mu R\theta \frac{v^2}{R} = 2T \sin\frac{\theta}{2}$$

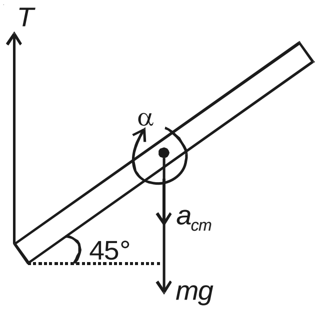
$$\Rightarrow \quad \mu R\theta \frac{v^2}{R} = 2T\frac{\theta}{2}$$

$$\Rightarrow \quad T = \mu v^2$$

Velocity of wave = $\sqrt{\dfrac{T}{\mu}} = v = R\omega = 2 \times 4 = 8$ m/s

51. Answer (4)

$Mg - T = Ma_{cm}$ ....(1)



$$T \times \frac{l}{2}\cos\theta = \frac{Ml^2}{12}\alpha$$

$$T\cos\theta = \frac{Ml}{6}\alpha \quad \text{...(2)}$$

$$\frac{l}{2}\alpha\cos\theta = a_{cm} \quad \text{...(3)}$$

$$T \times \frac{1}{\sqrt{2}} = \frac{Ml}{6} \times \frac{6\sqrt{2}g}{5l} \Rightarrow T = \frac{2Mg}{5} = 4\text{ N}$$

52. Answer (4)

Amount of discharge, $\Delta q = 15.75\ \mu C$

Initial charge, $q_0 = 25\ \mu C$

$\therefore$ Remaining fractional value of charge = $\frac{9.25\ \mu C}{25\ \mu C} \approx 0.37$

i.e. time taken in it is equal to time constant T

$T = CR = C_{eq}.R_{eq}$

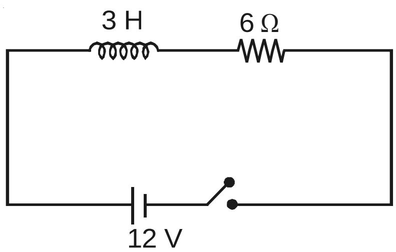
$$= 1 \times \left(\frac{6 \times 3}{6+3} + 1 + 1\right)\text{ s} = 4\text{ s}$$

53. Answer (4)

54. Answer (2)

After switching on

$$i = i_0\left(1 - e^{-t/\tau}\right) = 2(1 - e^{-2t})$$



If $i = 1A$

$1 = 2\ (1 - e^{-2t})$

$\Rightarrow \frac{1}{2} = 1 - e^{-2t} \quad \Rightarrow \quad e^{-2t} = \frac{1}{2}$

Now, $\frac{di}{dt} = \frac{i_0}{\tau}e^{-t/\tau} = 4e^{-2t} = 2$ A/s

55. Answer (4)

$L = 2.0 \times 10^{-3}$ H

$C = 5.0 \times 10^{-6}$ F

$Q_0 = 200\ \mu$C

Charge on capacitor

$Q = Q_0 \cos \omega t$

$$\omega = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{2 \times 10^{-3} \times 5 \times 10^{-6}}} = 10^4\text{ s}$$

$$\frac{dQ}{dt} = -Q_0\omega \sin \omega t$$

$$\left|\frac{di}{dt}\right| = \frac{d}{dt}\left(\frac{dQ}{dt}\right) = \left|-Q_0\omega^2 \cos \omega t\right|$$

$$= \left|-\omega^2 (Q_0 \cos \omega t)\right|$$

$$= \left|-\omega^2 Q\right|$$

$$= \left|-(10^4)^2 \times 100 \times 10^{-6}\right|$$

$$= 10^4 \text{ A/s}$$

$x = 4$

56. Answer (5)

If v_0 = unit of velocity, r_0 = unit of distance

Velocity of satellite

$$v_0 = \sqrt{\frac{GM}{3r_0}}$$

Velocity of particle

$$v_R = v_0 + v$$

$$= \sqrt{\frac{5}{4}}\, v_0$$

$$mv_1 r = m(v_0 + v)\, 3r_0$$

$$v_1 = \frac{1}{r}\sqrt{\frac{5}{4} GM\, 3r_0}$$

Applying law of conservation of energy

$$\frac{1}{2}mv_1^2 - \frac{GMm}{r} = \frac{1}{2}m(v_0 + v)^2 - \frac{GMm}{3r_0}$$

$\Rightarrow$ $r = 3\, r_0$ or $5\, r_0 = 5$ unit

57. Answer (8)

$$L = 10 \log_{10}\left(\frac{I}{I_0}\right)$$

$$30 = L_2 - L_1 = 10 \log_e\left(\frac{I_2}{I_1}\right)$$

$$\frac{I_2}{I_1} = 10^3 \left(\frac{\Delta p_2}{\Delta p_1}\right)^2 = 10^3$$

$$\frac{\Delta p_2}{\Delta p_1} \approx 32$$

q q q